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An Interdisciplinary Analysis of Multispectral Satellite Data for Selected Cover Types in the Colorado Mountains, Using Automatic Data Processing Techniques.

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Monthly Progress Report for January 1974

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E74-10316) AN INTERDISCIPLINARY ANALYSIS OF MULTISPECTRAL SATELLITE DATA FOR SELECTED COVER TYPES IN THE COLORADO MOUNTAINS, USING AUTOMATIC DATA PROCESSING (Purdue Univ.) 7 p HC $4.00 CSCL 08F G3/13

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MONTHLY PROGRESS REPORT
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A. Overall Status & Progress to Date

A.1 On January 31, 1974, R. M. Hoffer met with Dr. Roger Hicks and Dr. Rigden Joosten, PIMO, at JSC Houston. The meeting provided an excellent opportunity to review the current status of the SKYLAB contract, discuss the work that has been accomplished to date and review some of the characteristics of the quality of the SL-2 S-192 data. Some slides of the classification results obtained from the analysis of S-192 data from the Wabash Valley were also shown on behalf of Dr. Leroy Silva. These illustrations were enthusiastically received, and it was agreed that copies of such visual illustrations should be forwarded to the PIMO as soon as possible for their use in future briefings of NASA officials.

A review of the SKYLAB program for the next several months brought out the following points: S-192 data from SL-2 would probably not be available until after the S-192 data from SL-3 was available. Neither data set would be available by April 15 as had previously been anticipated. Rather, a more realistic date for receipt of the final S-192 data sets would be sometime during June, July or August. Hoffer stressed the importance of this date being as soon as possible and of being notified as soon as possible of the probable date when such data would be available, so that solid plans for analysis activities during the summer and fall could be programmed. He also pointed out that if such data is not available before July, there would probably be little opportunity for any field work during 1974, a situation which could have serious impact on the results obtained.

Hoffer indicated that because of the delays encountered in receipt of data, Purdue has cut the number of people involved in the SKYLAB activities to a mimimum during the Spring semester. This will allow a no-cost contract extension until August 31, 1974. Hicks and Joosten indicated that this plan would be acceptable.

During discussion of a possible contract extension, Hoffer indicated that work anticipated to be completed under the current contract would probably not be completed until early in 1975, given the current anticipated date of delivery of the S-192 data. It was agreed that Hoffer would supply a proposal

extension which would indicate the time involved to complete the work under the current contract, and would also indicate any additional work that would be done under such a contract extension. Hoffer indicated that due to the significant data processing and analysis procedures being developed under ERTS-1 projects which are applicable to SKYLAB data, and because of some of the current user agency contacts being developed, it would appear that a contract extension until May 31, 1975 would be most desirable and would provide a great deal of results for the relatively small cost involved.

It was also agreed that Hoffer would ask for funds to cover costs of computer time until August 31, 1974 from the SR & T grant from JSC. Computer time required after September 1, 1974, will be included in the SKYLAB contract extension proposal, unless a decision is made by NASA personnel to use SR & T funding to support the SKYLAB computation costs. The initial milestone plan indicated that the bulk of computation activity would occur four to six months after the final S-192 data sets are received. Currently anticipated delays would therefore put this analysis period as late 1974 or early 1975.

A.2 During the past month several new user agencies, such as the Colorado Automatic Data Processing Council and the National Park Service have been contacted. Terry Phillips of LARS' Data Handling Program spoke at the Denver Federal Center on remote sensing, automatic data processing and the current remote terminal experiment at Purdue. Paula Krebs of INSTAAR has also been working with several user agencies for the past several months, such as the Multiple Use Coordinators Office U.S. Forest Service, the National Park Service and others.

A.3 During January, work was completed on the unsupervised classification of Mesa Verde National Park from ERTS-1 MSS data (frame 1317-17204, June 5, 1973). An unsupervised classification was also performed on ERTS-1 MSS data from Sept. 27, 1972 (frame 1066-17254).

For both classifications the perimeter of the Moccasin Mesa Fire was mapped and the total burned acreage was estimated. These acreage estimates compare favorably with the acreage determined by manual interpretation of the SKYLAB SL-2 S-190B photographs; however, all three estimates were somewhat lower than acreage figures derived from the National Park Service Fire Map.

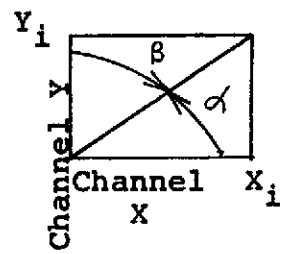
Both Classifications indicate a high degree of separability between the burn and adjacent areas. In addition, distinct spectral classes were differentiated within the burn. Analysis to date indicates that computer-aided analysis of multispectral scanner data has the capability to accurately map recent fires, and furthermore can differentiate distinct spectral classes within burned areas.

The original infrared imagery used by the NPS to prepare the fire map has been requested. Manual interpretation of this imagery by LARS personnel will be accomplished to more critically evaluate the analysis results. Indications are that error may be present in the NPS map.

A.4 Members of the Geological Features Survey have requested the LARS programming staff, funded by a SR & T contract, to enhance the photointerpretation characteristics of the data by preprocessing techniques. These techniques will be applied to both SKYLAB and ERTS data and the value of these techniques will be assessed for geologic applications as part of the SKYLAB activities. Some of these methods are described below.

A.) The first technique involves calculating ratios and two methods are currently being investigated. 1) Calculating the ratio of the reflectance value of one channel to the reflectance value of the next highest channel and 2) calculating the ratio of the reflectance values of one channel to the reflectance value of the sum of the channels.

B.) The next technique involves calculating the direction cosine and total magnitude of the reflectance of the channels. This technique tends to reduce the effect of topography on the data. The direction cosines are computed for each sample producing a number of angles corresponding to the number of channels of data available and an additional channel which contains the magnitude of the spectral vector for each data point. The following relationships explain the method used to determine the directional cosine and the total magnitude for a two dimensional space.



$$\cos^{-1}\alpha = \frac{X_i}{(X_i^2+Y_i^2)^{1/2}}$$

$$\text{Magnitude} = (X_i^2+Y_i^2)^{1/2}$$

C.) The third technique used to enhance the data involves a picture gradient which may be defined as follows.

$$\text{Gradient} = |\nabla| = \left((X_{i,j+1} - X_{ij})^2 + (X_{i+1,j} - X_{ij})^2\right)^{1/2}$$

This parameter is defined as the rate of change in the spectral reflectance between a data point and its nearest neighbors. Presently it appears to enhance the edge characteristics of any particular spectral unit or linear feature.

A method for quantitatively describing the ruggedness of an area is also under investigation. This ruggedness coefficient should reflect any subdued topography in a glaciated region and unsubdued topography in a non-glaciated region. Hopefully this ruggedness should be reflected in the spectral characteristics of an area and consequently be classified by computerized methods. The ruggedness coefficient is defined as follows.

$$R = \frac{\text{Length of stream segments x maximum relief}}{\text{Area}}$$

Ruggedness coefficients are currently being calculated for areas in which the geology and geomorphology is understood. The resulting information will then be compared to the spectral characteristics of the data.

B. Recommendations

B.1 The data tapes from SL-2, June 5, 1973, were received at LARS on January 9, 1974. The bulk MSS tapes were then reformatted by the LARS programming staff to be adaptable to the LARSYS software system. These tapes contained uncorrected data, i.e. the conical pattern in which the MSS data was collected does not appear on the computer printouts and consequently serious distortions of land forms occur any place away from the nadir track. Consequently location of known ground reference points has been made extremely difficult. LARS programming staff has been requested to place the conical scan pattern back into the data so these reference points may be located. Any additional data sent to LARS should have the conical scan pattern placed back into the data.

B.2 Initial inspection of the wavelength bands on the tapes indicated that there were 13 spectral bands, two of which were indicated to be in the thermal infrared region. At closer inspection however we noted that the 1.2-1.3 spectral band was missing but a 12.0-13.0 wavelength band was present. A consequent investigation of the data has indicated that this 12.0-13.0 band has been incorrectly identified and should be specified as the 1.2-1.3 spectral band. All principal investigators using MSS data should immediately be notified of this error.

B.3 Information concerning the expected date of delivery of the final SL-1/SL-2 and SL-1/SL-3 S-192 data tapes must be forwarded to the Principal Investigator before a proposal can be written to extend the present contract or to generate a new Milestone Plan. This information should be sent as soon as possible.

C. Expected Accomplishments

C.1 During the next reporting period work is expected to continue on developing the above mentioned preprocessing techniques for enhancing the photointerpretation and machine classification characteristics of the MSS data. A preliminary evaluation of the ruggedness coefficient will also be completed during the next 60 days.

C.2 Since the MSS data contains vast areas of snow cover, a spectral analysis of snow will be initiated during this period. One of the major constraints in the present ERTS program is the inability of the ERTS-1 satellite to spectrally differentiate between clouds and snow. Analysis of the SKYLAB data in mountainous areas that are snow covered should resolve many of the questions as to which bands are most useful for successfully differentiating clouds from snow and for spectrally differentiating wet snow from dry snow.

D. Significant Results

There are no author identified significant results in this report.

E. Summary Outlook

Since the initial data receipt was delayed until January, 1974, from the expected date of August, 1973, a serious delay has occurred. The data received last month, even though it does contain serious geometric distortions, is currently being analyzed with the LARSYS

software system. The data expected to be received during the summer of 1974 is expected to have all of the geometric distortions and most of the noise removed. This output product will satisfy all of our data requirements.